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THE DIGESTIBILITY OF ANIMAL PRODUCTS AND CEREALS BY MINKS *

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With the development of a number of successful diets, the production of minks for fur has become an important industry. Few studies have been undertaken, however, to determine the specific nutritive requirements of the animals. To obtain this information, the Fish and Wildlife Service, of the United States Department of the Interior, the Bureau of Animal Industry of the United States Department of Agriculture, and Cornell University are cooperating in nutrition studies of minks under the special research fund of the Secretary of Agriculture (Bankhead-Jones Act of June 29, 1935). As part of an extensive research program, digestion studies have been made of some of the animal products and cereals commonly used in feeding minks.

In these investigations 61 minks were used and 13 different diets were tested. Six of the diets (1, 2, 4, 6, 15, and 16) were composed of animal

TABLE 1.--Ingredients in the six mixed diets used in digestion studies of minks

Ingredient	Proportion of ingredient in diet No.--					
	1	2	4	6	15	16
	Parts	Parts	Parts	Parts	Parts	Parts
Horse meat	35	.....	50	50	50	50
Horse liver	5	.....	.....	.....	.....	.....
Beef (ground)	.....	44	.....	.....	.....	.....
Dry diet 26 <u>1</u> /	32	44	.....	.....	40	40
Dry mixture A <u>2</u>/	.....	.....	.....	30	.....	.....
Cornstarch (cooked)	.....	.....	25	.....	.....	.....

1/ Diet 26 was composed of wheat flakes, 15 percent; corn flakes, 42.1, beef scrap, 20; dried milk, 6; soybean meal, 5; wheat germ, 4; cheese meal, 2; dried yeast residues, 2; white fish meal, 2; bonemeal, 1; salt, 0.5; and reinforced cod-liver oil, 0.4 percent.

2/ Dry mixture A was composed of rolled oats, 27 percent; white corn meal, 27; wheat flakes, 27; yeast, 13; and bonemeal, 6 percent.

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products supplemented in various proportions with cereals, as shown in table 1. One diet (26) was a commercial dog food, and was fed both alone and in combination with meats. The other six diets consisted entirely of meat products--No. 3, horse meat; 14, canned fish; 18, beef tripe; 25, beef spleen; 28, horse liver; and 29, horse meat and canned fish mixed in equal parts.

The horse meat and horse liver were frozen products purchased on the open market. The beef spleen and tripe, obtained from a local slaughter house, were ground and kept frozen until used. The tripe included the rumen, reticulum, and abomasum of the beef, emptied of their contents and rinsed once with cold water, before being ground, to remove extraneous material. The cereals in the dry mixture included both commercial flaked products and ground raw cereals. The cornstarch in diet 4 was steam cooked. Further details regarding the feeds are given on page 3. Analyses of the mixed diets and of the meats fed are shown in table 2.

TABLE 2.--Analyses of the diets used in the digestion trials

	Composition (dry basis) of--				
	Crude protein	Ether extract	Nitrogen- free extract	Crude fiber	Ash
	Percent	Percent	Percent	Percent	Percent
1.....	38.9	9.6	41.9	3.6	6.0
2.....	31.0	24.1	36.6	2.2	6.1
3.....	79.4	10.4	6.2	.....	4.0
4.....	25.2	2.9	70.1	.....	1.8
6.....	41.4	7.0	43.0	1.0	7.6
14.....	70.6	7.3	1.8	.....	20.3
15.....	40.0	13.9	37.0	1.9	7.2
16.....	46.2	10.4	33.2	2.9	7.3
18.....	69.0	19.4	4.5	.....	7.1
25.....	72.0	16.6	7.7	.....	3.7
26.....	22.3	7.9	58.6	2.6	8.6
28.....	78.8	8.1	9.3	.....	3.8
29.....	72.2	12.4	2.1	.....	13.4

The procedure followed throughout the digestion studies was essentially the same as that described by Hodson and Maynard (1938), except that the experimental period was extended to 5 days. A mink was placed on a metabolism cage and fed daily a measured quantity of the diet to be tested. After 3 or 4 days had elapsed, feces were collected, for 5 consecutive days, and chemical analyses were made of samples from both the composite feed and the feces. The digestibility of the various diets were calculated from the data thus obtained. The test diet was fed to a group of 2 to 12, usually at least 4, minks. Table 3 gives the average percentage of digestibility of the food elements.

TABLE 3.--Digestibility coefficients

Diet No.	Minks tested	Proportion digested of--				
		Dry matter	Crude protein	Ether extract	Nitrogen-free extract	Crude fiber
	Number	Percent	Percent	Percent	Percent	Percent
1.....	6	78.4	80.1	89.5	79.8	35.6
2.....	2	78.4	81.7	91.9	73.2	48.4
3.....	5	.....	86.0	88.4	.....	.....
4.....	6	75.2	82.9	.....	73.1	.....
6.....	6	72.7	86.2	82.3	65.9	24.9
14.....	12	.....	71.5	95.3	.....	.....
15.....	3	70.2	72.8	91.5	64.7	20.4
16.....	3	72.6	79.1	88.8	67.8	45.5
18.....	4	.....	76.2	79.5	.....	.....
25.....	4	.....	83.9	78.1	.....	.....
26.....	4	74.8	72.1	89.5	79.3	45.3
28.....	4	.....	92.6	88.1	.....	.....
29.....	2	.....	75.2	97.2	.....	.....

The use of fecal markers and X-rays brought out the fact that food eaten by minks is completely eliminated in less than 15 hours. This rapid elimination is probably due to the shortness of the digestive tract, which averages about 60 inches in length. In minks the ratio of body length to intestinal length is about 1 to 4. Cats have a similar ratio, but dogs have a relatively longer digestive tract, the ratio being 1 to 6 (Dukes, 1937). From the results of experiments with minks it seems safe to assume that a 5-day collection period is sufficiently long to insure reliability of data.

Of the dry matter in the various diets, 70 to 78 percent was digested. Usually the highest percentages of digestibility were obtained when raw meats were included. In all diets except No. 26 the crude protein was more completely digested than was the dry matter.

Ninety-three percent of the protein of raw horse liver, 86 percent of that of raw horse-muscle meat, and 84 percent of that of raw beef spleen were digested. The addition of cereals to horse meat (diet 6) did not appreciably affect the digestibility of the protein. The protein of diet 26, supplied by beef scrap, fish meal, and cereals, was only 72 percent digested. When diet 26 was added to horse meat (diet 1) a lower digestibility of the protein resulted as compared with diet 3. In this trial the lower digestibility may be in part accounted for by the fact that the meat products were dried. Packing-house meat byproducts may contain much connective tissue that is less digestible. A higher content of connective tissue also may explain the low digestibility of the protein of beef tripe (diet 18). To study the effect of cooking and drying upon the digestibility of the protein, horse meat was processed before being compounded into diets. When the meat was cooked (autoclaved) under 15 pounds of pressure for 2 hours (diet 15) the protein was less than 73 percent digested. Horse meat dried at 80° C. for 24 hours (diet 16) was

likewise less digestible than the raw article (diet 3). It is of interest that there was no significant difference in the digestibility of the proteins of diets 1 and 2. The former contained horse meat and the latter beef. The digestibility of the protein in canned fish (diet 14) was about the same as that in dried or cooked meat and lower than that in raw meats.

The data indicate that the fats (ether extract) were generally well utilized. Their apparent digestibility was, in most cases, higher than that of protein or dry matter. It is probably safe to conclude that fat is an excellent source of energy for minks. Long-time studies are necessary, however, to determine the quantity of fat that should be incorporated in the ration.

The diets used were all low in fiber, and this fact probably explains the wide variations obtained--20 to 48 percent of the crude fiber of the various feeds being digested. It is interesting that minks apparently digest appreciable quantities of crude fiber when the feed contains only 1 to 3 percent. Studies should be made using diets containing larger quantities of fiber, although one investigation (Hodson and Maynard, 1938) has indicated that an excess of bulky feeds in the mink diet is probably undesirable.

The digestibility of carbohydrates by minks is a question much discussed by fur producers. Some data in that respect were obtained in the present study, as a number of the diets contained one-third or more of carbohydrates in the form of cooked starch or raw cereals. The digestion coefficients given in table 3 indicate that 65 to 90 percent of the nitrogen-free extract in the high carbohydrate diets was digested. It is evident, therefore, that starch is fairly well digested even when fed as raw cereals. To test this question further, starch analyses were made of the samples obtained from diets 1 and 4. The values from these analyses indicate that the starch was about 90 percent digested. Additional work is in progress on the digestibility of raw and cooked starch as found in cereal grains.

In the course of the work, some of the experimental diets that were employed caused loose feces, entirely lacking in form, and in some cases bordering on diarrhea. It was found that the addition of ground, dried tomato pomace as 5 percent of the wet ration rapidly corrected the condition. After the addition of the pomace, the feces assumed good form and consistency and so remained as long as it was included. When the tomato pomace was removed from the diet, the feces again became loose.

Summary

Digestion studies with minks were made using 13 different diets. The data showed that raw meat was more digestible than dried or cooked meat and that both horse meat and beef were more digestible than canned fish. The carbohydrate portion of the diets was less digestible than was either the protein or the fat. Horse liver and beef spleen were as fully utilized as horse-muscle meat, but beef tripe was of lower value.

The evidence obtained indicates that fats and carbohydrates are excellent sources of energy, but that additional work must be done to show the level at which these nutrients can safely be incorporated in the diet of minks.

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